



**COLLEGE OF ENGINEERING, SCIENCE & TECHNOLOGY (CEST)**

**SCHOOL OF ELECTRICAL & ELECTRONICS ENGINEERING**

**CERTIFICATE IV IN ELECTRONIC ENGINEERING**

**EEC421 – ELECTRONIC INSTRUMENTATION**

**FINAL EXAMINATION – QUARTER 4, 2019**

**DATE:** As per timetable

**TIME:** As per timetable

**TIME ALLOWED: 2 HOURS 10 MINUTES**

**INSTRUCTIONS:**

1. *You are allowed 10 minutes Extra reading time during which you are NOT to write.*
2. *Begin each section on a new page and use both sides of the sheet.*
3. *Write your candidate-number at the top of each attached sheet.*
4. *Insert all written foolscaps, graph paper, drawing paper, etc. in their correct sequence and secure with string.*
5. *For all sheets of paper on which rough/draft work has been done, cross each one through and ATTACH these to your answer scripts.*
6. *Write clearly the number(s) of the question(s) attempted on the top of each sheet.*
7. *Show all working clearly where necessary.*
8. *Programmable calculators are not allowed, especially the ones that does the conversions of number systems.*
9. *Check your work before leaving the exam hall.*
10. **ANSWER ALL QUESTIONS.**

## Section A – Multiple Choice

[20 marks]

*Choose the appropriate answer from each question by writing the alphabet beside the question number in your answer booklet.*

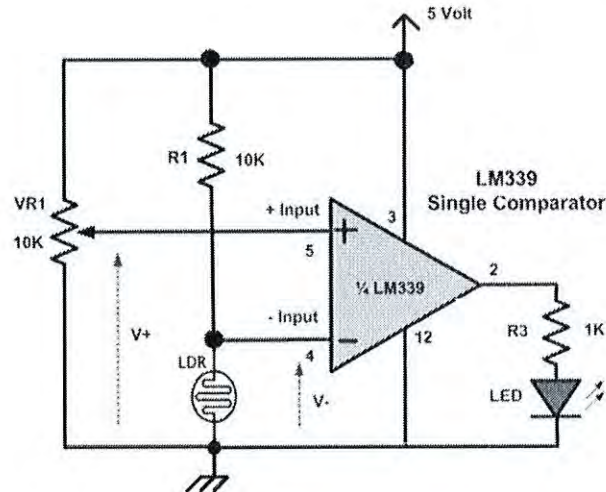
1. Newton (N) is the SI unit for?
  - A. Force
  - B. Weight
  - C. Displacement
  - D. Pressure
  
2. In ADCs, two factors that determine the accuracy of the digital value that captures the original analog signal are;
  - A. filtering and aliasing
  - B. quantization level and sampling rate
  - C. aliasing and sampling rate
  - D. bit rate and aliasing
  
3. A device which has several data inputs, one data output, and selection inputs is known as a;
  - A. Multiplexer
  - B. De-multiplexer
  - C. Analog to Digital Converter
  - D. Digital to Analog Converter
  
4. A weight measurement instrument is calibrated between 200 grams and 1200 grams. The scale span of the instrument is;
  - A. 200 grams
  - B. 1000 grams
  - C. 1200 grams
  - D. 1400 grams
  
5. The smallest change in a measured variable to which an instrument will respond is;
  - A. Resolution
  - B. Precision
  - C. Sensitivity
  - D. accuracy
  
6. If there are any frequency components in the analog signal that exceed the Nyquist frequency, an unwanted condition occurs known as
  - A. Nyquist Error
  - B. Transient Response
  - C. Steady State Error
  - D. Aliasing

*Please Turn Over*

7. The errors mainly caused by human mistakes are
- A. systematic error
  - B. instrumental error
  - C. gross error
  - D. random error
8. A sensor is designed for measuring temperature from  $-30^{\circ}\text{C}$  to  $+80^{\circ}\text{C}$  and it outputs 1.2V to 2.5V. What is the sensor's input full scale reading?
- A.  $50^{\circ}\text{C}$
  - B. 1.3V
  - C. 1.2V to 2.5V
  - D.  $-30^{\circ}\text{C}$  to  $+80^{\circ}\text{C}$
9. Determine the resolution, expressed as a percentage, for an 8-bit DAC.
- A. 0.392%
  - B. 39.2%
  - C. 100%
  - D. 255%
10. Which of the following is NOT a method of circuit protecting the next element of the control system?
- A. Series capacitor to limit line current
  - B. Fuse to break if the current does exceed a safe level
  - C. Zener diode circuit to protect against high voltage and wrong polarity.
  - D. Opto-isolator to isolate circuits completely
11. The two types of errors, Instrumental error and Environmental error, are classified under;
- A. Gross Error
  - B. Systematic Error
  - C. Random Error
  - D. Human Error
12. What is the advantage of electrical Signal Conditioning?
- A. Converts resistance changes to voltage changes
  - B. Increases signal voltages
  - C. Removes unwanted frequency components
  - D. All of the above

*Please Turn Over*

13. A LDR used as a light sensor turns on and off the LED. If the voltage tapped across the variable resistor ( $VR_1$ ) is 2.5V which is applied to the (+) input of the comparator (LM339), what voltage across the LDR will turn on the LED?



- A. 2.0V  
 B. 3.0V  
 C. 4.0V  
 D. 5.0V
14. A Pitot Tube is used for the measurement of;  
 A. Temperature  
 B. Flow  
 C. Weight  
 D. Pressure
15. A LDR used as a light sensor is connected as a voltage divider circuit with a  $1k\Omega$  resistor. If the supply voltage is 10V, what is the output voltage across the resistor with LDR having a resistance of  $4k\Omega$ ?  
 A. 8V  
 B. 2V  
 C. 2.5V  
 D. 10V
16. Which of the following is commonly used for the measurement of Force?  
 A. Photodiode  
 B. Optical Pyrometer  
 C. Piezoelectric Material  
 D. Thermistor

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17. Thermocouples

- A. require reference junction compensation
- B. are most commonly used as temperature transducer
- C. have an ion output voltage level
- D. all of the above

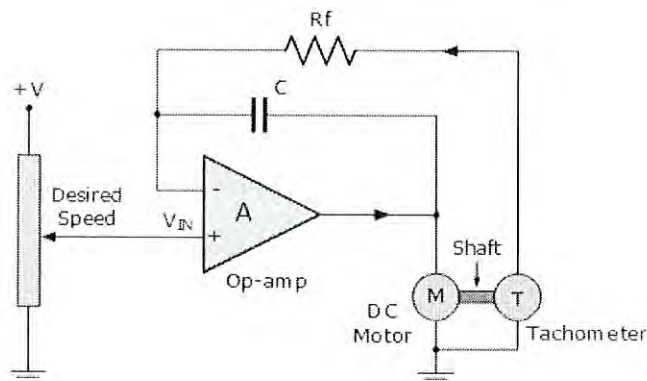
18. A resistor's measured value of resistance is  $33.05\Omega$ , whereas its true value is  $33.0\Omega$ . What is the absolute error of the measurement?

- A.  $0.05\Omega$
- B.  $0.05k\Omega$
- C.  $33.25\Omega$
- D.  $33.0\Omega$

19. The sensitivity of a strain gauge whose output is  $10\Omega$  for an input change of 10 grams is;

- A.  $1\Omega/\text{gram}$
- B.  $10\Omega/\text{gram}$
- C.  $1\text{ gram}/\Omega$
- D.  $10\text{ gram}/\Omega$

20. A simple closed-loop motor controller circuit is shown below. Identify the Controller.



- A. Feedback Resistor,  $R_f$
- B. DC Motor
- C. Tachometer
- D. Op-amp

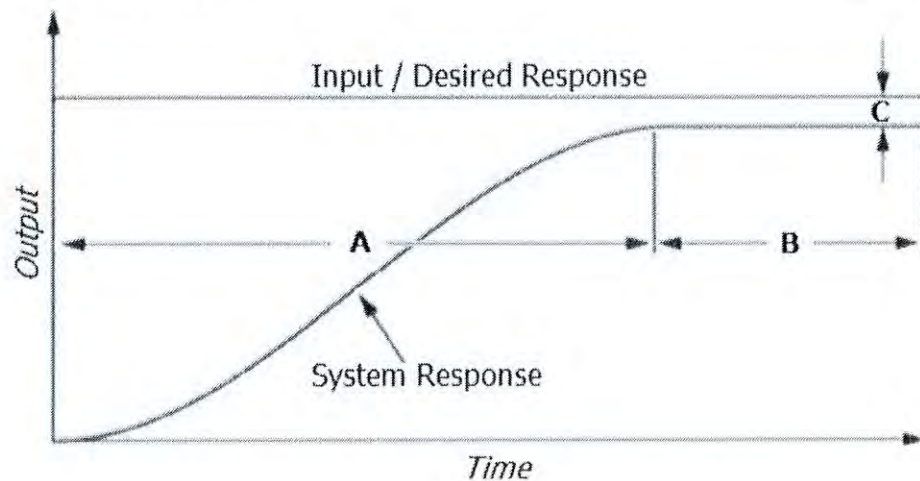
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## Section B – Short Answers & Calculations (80 marks)

*There are 4 parts to this section. Answer ALL questions. Show your calculations clearly where required.*

### PART I – Control System Principles (20 Marks)

1. A *Control Loop* is a group of instruments that work together to keep a process variable at its desired value, referred to as set point. There are four components in a control loop. List them. (4 marks)
2. Explain clearly, what do you understand by the following terms;
  - a. Set Point (1 mark)
  - b. Measured Variable (1 mark)
  - c. Error (1 mark)
3. A control system provides an output or response for any given input or stimulus. The input represents a desired response; the output is the actual response. Figure below shows the response for a system. Name the sections marked A, B and C. (3 marks)



4. Define the following terminologies used measurement systems;
  - a. Span (1 mark)
  - b. Resolution (1 mark)
  - c. Repeatability (1 mark)
5. With an aid of a block diagram, explain clearly what you understand by a 'Closed Loop Control System'. (5 marks)

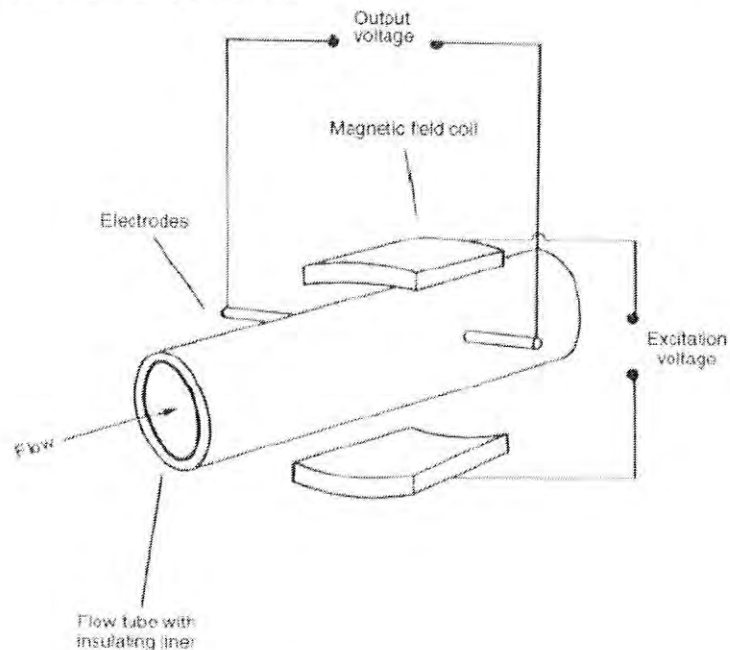
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6. Name the two types of errors you encountered while taking the measurements in the lab during your lab practical's. For each, explain what the error was. (2 marks)

**PART II – Sensing Elements**

**(20 Marks)**

1. What is the difference between a Sensor and a Transducer? (3 marks)
2. A sensor is designed for measuring temperature from  $-55^{\circ}\text{C}$  to  $+150^{\circ}\text{C}$  and it outputs 3.5V to 1.5V.  
Find the;
- a. Range of the sensor, (1 mark)
  - b. Span of the sensor, (1 mark)
  - c. Sensors input full scale reading, (1 mark)
  - d. Output full scale reading. (1 mark)
3. Figure below show an Electromagnetic Flow Meter for flow measurement. Briefly describe its operation. (4 marks)



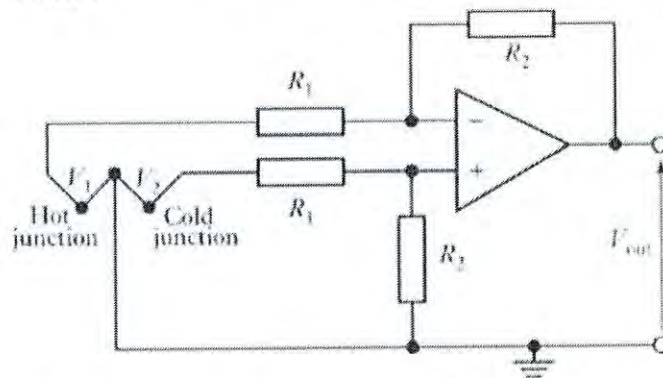
4. Name any two sensors/transducers you will use for the measurement of the following;
- a. Force
  - b. Temperature
- (3 marks)
5. List two limitations of using an optical Pyrometer. (3 marks)

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6. Explain clearly the Seebeck Effect. (3 marks)

**PART III – Signal Conditioning (20 Marks)**

1. What do you understand by Signal Conditioning? (2 marks)
2. A thermistor is used for temperature measurement.
  - a. Explain how you will read the change in thermistor output in terms of voltage. (2 marks)
  - b. Show using an aid of a circuit diagram how you will read this output voltage. (3 marks)
  - c. If the voltage is to be fed to a comparator circuit, show how you will connect the circuit. (3 marks)
3. Calculate the value of R for a passive RC Low Pass Filter of cut-off frequency of 65kHz. Use  $C = 470\text{pF}$ . (2 marks)
4. The difference in voltage between the emfs of the two junctions of the thermocouple is being amplified. A temperature difference between the thermocouple junctions of  $30^\circ\text{C}$  produces an emf difference of  $750\mu\text{V}$ , with an output of  $18\text{mV}$ .



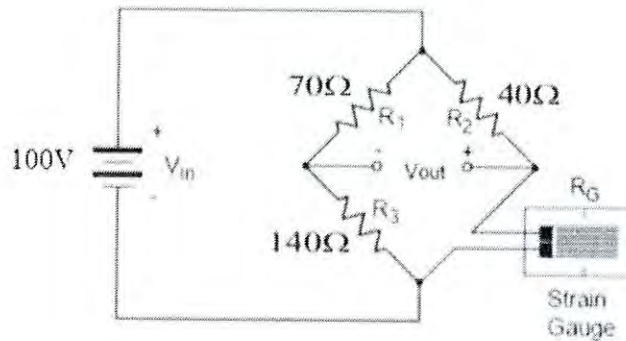
- a. Calculate the ratio of the resistance,  $R_2/R_1$  (3 marks)
- b. If  $R_1 = 12\text{k}\Omega$ , calculate the value of  $R_2$ . (2 marks)

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5. A strain gauge was connected to a Wheatstone bridge circuit as shown below. Calculate the output voltage across the  $V_{meas}$  terminals of the bridge circuit if the strain resistance of the strain gauge is  $120\Omega$ .

(3 marks)

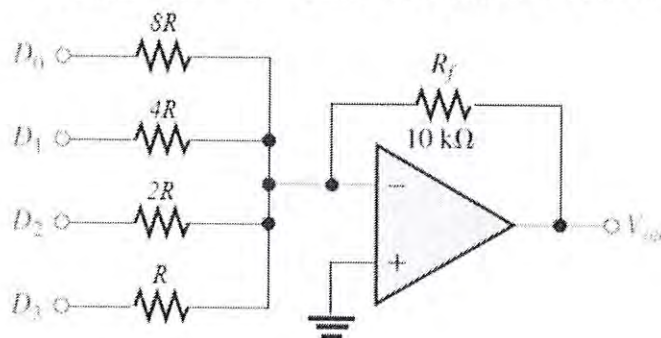


#### PART IV – Signal Processing

(20 Marks)

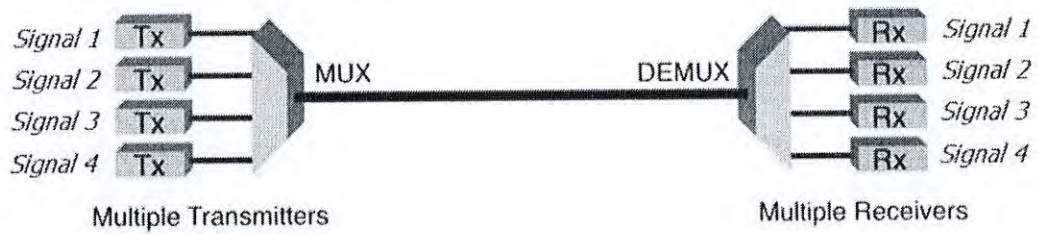
- A 4-bit DAC has a current output. For a digital input of 1010, an output current of 15mA is produced. What will  $I_{OUT}$  be for a digital input of 1101? (3 marks)
- Explain the following terms used in analog to digital conversion;
  - Sampling (2 marks)
  - Quantization (2 marks)
- A 6-bit ADC is converting a temperature signal which has a measuring range of  $0^\circ\text{C}$  to  $600^\circ\text{C}$ . Calculate the resolution of the temperature measuring instrument. (3 marks)
- For the given DAC, determine the;
  - Resolution, (3 marks)
  - Full scale output. (2 marks)

Assume  $V_{REF} = 15\text{V}$ ,  $R = R_f = 10\text{k}\Omega$  and  $R_L$  is much smaller than  $R$ .



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5. Explain briefly how the following four channel MUX-DEMUX system which can be used in a sensor network will operate. (5 marks)



The End

-----GOOD LUCK-----